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Pest Control and Pesticides

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Follow the Instructions!

SPRING, besides being the time of year when traditionally a young man's fancy lightly turns . . . . is also a time when the average householder begins to think of lawns and bulbs and herbacious borders; the time when—perhaps unconsciously—he feels himself at one with " the land " and with mother Nature.

Small wonder, therefore, that any suggestion of wind-drift from sprayed pesticides interests—and alarms—him! Despite the fact of spraying being an all-the-year-round function by some, spring is still the " spraying season " in the eyes of many laymen and once there is a whisper of a spray being wind-borne, then the hunt is on and no mistake!

Our plea, therefore, is twofold: first, an accident is to be regretted at any time and human beings being what they are, may happen when least expected. On the other hand, we wonder if the user by following the manufacturers' instructions " to the letter " may not avoid all but the most isolated case which, perhaps due to a combination of circumstances, cannot be avoided. A careful following of makers' instructions by users will reduce trouble to the minimum.

Secondly, we offer a plea for public relations' to counteract any possible wrong impression which may be gained by the public: allegations by individuals or bodies of people, elected representatives or the like, which are felt to be untrue, should be countered immediately in the press by an adequate, all-embracing service of public relations. In this way, the industry is safeguarding and insuring itself against any possible misinformed public opinion.

MALATHION

The Safe Organo-phosphorus Insecticide

By D. BOOCOCK (*Technical Director, Standardised Disinfectants Co., Ltd.*)

SINCE MALATHION was first introduced as an experimental material in 1949 it has established a firm position as one of the most generally useful insecticides available today. The reasons for this are three-fold:—

(i) it is effective against a wide range of agricultural, storage, public health, domestic and livestock pests;

(ii) it controls many pests which have developed resistance to DDT, dieldrin, and other insecticides of the chlorinated hydrocarbon group;

(iii) although it is an organo-phosphorus compound its toxicity to warm blooded animals is very low, and it is one of the safest insecticides in common use.

Chemical and Physical Properties

Malathion was introduced in 1949 by the American Cyanamid Company as Experimental Insecticide 4049 and was subsequently known for a brief period as malathon. The coined name malathion is now, however, universally accepted. The British Standards Institute has adopted for it the chemical name S-1:2-di (ethoxycarbonyl) ethyl dimethyl phosphorothiolothionate. It is also described chemically as O,O-dimethyl phosphorodithioate of diethyl mercaptosuccinate and by several other alternative chemical names. Its structural formula is:—

$$
\begin{array}{lllll}
 & S & & O & \\
 & \uparrow & & \| & \\
(CH_3O)_2. & P - S - & CH & - C - O. & C_2H_5 \\
 & & \| & & \\
 & & & O & \\
 & & & \| & \\
 & & CH_2 & - C - O. & C_2H_5
\end{array}
$$

Technical malathion contains a minimum of 95% of the active chemical and is a yellow to dark brown liquid with a mercaptan-like odour. A refined grade of malathion, known as *premium grade*, is also available which is lighter in colour and has a less pronounced odour. The odour of the premium grade becomes somewhat stronger, however, during storage for an appreciable time. Although the smell of malathion from a newly opened container is unpleasant, it is not nearly so bad when diluted for spraying and fades away within a day or two of application. Several pesticides in commom use smell much worse.

Malathion is very slightly soluble in water (145 ppm), and of only limited solubility in paraffin oils. It is miscible, however, with a number of organic solvents and aromatic petroleum distillates. It hydrolyses above pH 7 and below pH 2. It is stable to light but is decomposed by high temperatures. It reacts with iron, copper, and lead and malathion preparations may gel if kept in iron or tin plate containers. For this reason, it is most important that liquid malathion formulations are packed in drums with an internal lining of a suitable stoved phenolic or epoxy resin.

Malathion is compatible with most other insecticides including DDT, lindane, and other chlorinated hydrocarbon insecticides but gradually decomposes if combined with toxaphene. It is compatible with pyrethrins but the insecticidal action of malathion is antagonised by piperonyl butoxide. Malathion formulations may be mixed in the spray tank with copper fungicides but the mixture is best sprayed soon after preparation. Combined sprays of Bordeaux mixture, lime sulphur and other alkaline materials should be avoided.

Malathion can be estimated colorimetrically in the technical form and in emulsifiable concentrates, dispersible powders and dusts by decomposing it in alcoholic solution with alkali and converting the sodium O,O-dimethyl dithiophosphate thus formed into the cupric complex which dissolves in methyl chloroform to give an intense yellow solution. A shorter method using alcohol-ferric oxidation is also available and, for the most accurate work, Jura's polarographic method. In plant materials malathion can be determined with accuracy to well under 1 ppm.

A good emulsifiable concentrate should emulsify immediately on pouring into water and form a stable emulsion as demonstrated by this simple test with MALASTAN EC-50.

Photo—Courtesy The Standardised Disinfectants Co., Ltd.

Formulation

Malathion is available in a wide range of formulations including emulsifiable concentrates, ready-for-use solutions for fogging and space spraying, oil miscible concentrates for producing such solutions, aerosols, water dispersible powders, dusts, and baits. Malathion is not an easy insecticide to formulate, however, and care should be exercised by users in order to obtain a good product from a reliable manufacturer. Buyers, whose sole criterion is price, will experience expensive disappointment sooner or later if they disregard this advice not only with malathion but with other pesticides.

Manufacture of emulsifiable concentrates of good quality becomes increasingly difficult as the concentration of malathion in them is raised. Excellent products containing 5 lbs. malathion per Imperial gallon (50% wt./vol.) can be produced but products containing 57.5% wt./wt., which are widely recommended because this is equivalent in a xylol base formulation to 5 lbs. malathion per U.S. gallon, are extremely difficult to formulate to a satisfactory standard. In countries where the Imperial and metric systems of measurement are used, emulsifiable concentrates containing 50% wt./vol. are, of course, by far the most convenient to use.

Dust and dispersible powder formulations should be based on carefully selected carriers which have been proved not to cause decomposition of malathion. In addition, wettable powders should mix easily with water to form a stable suspension. Obvious points—but so often ignored.

Toxicity

Malathion has a very low degree of both acute and chronic oral toxicity to mammals. Contamination of eyes and skin presents little hazard, and inhalation seems to have no serious effect on the lungs. No toxic effects were observed in men exposed during fogging operations for mosquito control.

Malathion is a weak cholinesterase and succinoxidase inhibitor, and it is rapidly metabolised in warm-blooded animals.

Although malathion is an organo-phosphorus chemical it is, to quote the United States Department of Agriculture, " one of the safest insecticides to handie." The U.S.D.A. has accepted label claims for its use on a considerable number and variety of edible crops, for protection of grain and other foodstuffs in store, for spraying livestock, and for fly control in dairy barns—a situation where the use of DDT and most other insecticides is prohibited in the United States. In Canada, grain may be protected from insect infestation by addition of malathion dusts, and a tolerance limit of 8 ppm in small grains has been set both there and in

A good emulsifiable concentrate should emulsify immediately on pouring into water and form a stable emulsion as demonstrated by this simple test with MALASTAN EC-50.

Photo—Courtesy The Standardised Disinfectants Co., Ltd.

the U.S.A. In Great Britain, malathion sprays are now recommended for disinfestation of food and commodity stores, and it has been specifically excluded from the Agriculture (Poisonous Substances) Regulations. The Ministry of Agriculture, Fisheries and Food, in their recommendations for safe use of agricultural chemicals, consider malathion should not present a hazard to operators provided the following voluntary precautions are observed: avoid prolonged breathing of spray mist; avoid contact with the skin; wash thoroughly after use; take particular care after using demeton, parathion, schradan or other toxic organo-phosphorus materials as harmful cumulative effects might arise. Provided there is a minimum interval of seven days between the last application and harvesting, on present information its use on any growing edible crop should present no hazard to consumers.

In the writer's opinion, the wide acceptance of malathion as a safe insecticide by Government officials is of far more interest to the general user of insecticides than reams of toxicological data as Governments now rightfully give the most serious consideration to all aspects of toxic hazard relating to pesticides.

Toxicity of malathion compared with some other commonly used insecticides. (*Based on figures given in WHO Tech. Rept. Series No.* 114).

INSECTICIDE	Acute Oral LD_{50} (mg/kg)		Dermal LD_{50} (mg/kg)	
	Males	Females	Males	Females
Malathion ..	1375	1000	4444	4444
Dipterex ..	630	—	—	—
Lindane ..	—200*—		500	—
DDT	113	118	—	2510
Diazinon ..	108	76	—	180
Toxaphene ..	90	—	2300	80
Dieldrin ..	46	46	90	60
Endrin.. ..	17.8	7.5	—	15
Parathion ..	13.0	3.6	21.0	10.9
Demeton ..	6.2	2.5	14.0	8.2
TEPP	2.0	1.2	—	—

* *Sex not specified.*

Control of Agricultural and Horticultural Pests

Malathion controls a wide range of insect pests attacking field and plantation crops, fruit trees, ornamental trees, and flowers. Its safety in use is one of its most important advantages to farmers and growers, and it can replace parathion and other contact organo-

phosphorus chemicals for most purposes. The fact that it can be applied safely within seven days of harvesting without hazard either to those picking the crop or those consuming it is frequently an outstanding point in its favour. Its low toxicity also recommends it for use by primitive communities.

Malathion has proved particularly effective against aphis, white fly, leafhoppers, scale insects, mealy bugs, and fruit flies. It is valuable for control of agricultural pests which have developed resistance to chlorinated hydrocarbon insecticides. Malathion kills the active stages of red spider mites but is of little value against the eggs. Laboratory tests by topical application to the abdomens of *Schistocerca gregaria* adults show its toxicity to be low and it would appear to have no future for locust control.

The formulations of malathion of most use to the farmer and grower are 50% emulsifiable concentrates, 25% water dispersible powders, and 4% dusts. Sprays can be applied either with ground machines or from aeroplanes, using either high or low-volume methods of application. It is important always to obtain good cover of the crop. For low-volume application an emulsifiable concentrate formulation is preferable. For ultra-low-volume application at rates of 1-3 gallons per acre, solutions in non-phytotoxic white oils should be tried. For use in glasshouses atomisable solutions of malathion are available.

In a brief general review of this nature it is impossible even to mention all the agricultural pests against which malathion is being successfully used, and one can do little more than provide a few pointers. Over a hundred label claims and tolerances have been published by the U.S.D.A. alone.

Of American uses the campaign in Florida against the Mediterranean Fruit Fly is of exceptional interest. This pest first menaced the Florida citrus industry in 1929, and was only controlled by destruction of many thousands of boxes of fruit and an embargo on all fruit shipments. It cropped up again in 1956 and spread rapidly, threatening Florida growers once again with devastating losses. Prompt action, however, was taken and a campaign to spray thousands of acres with malathion from the air was carried out at a cost of over $10,000,000. The spray consisted of malathion dispersible powder and partially hydrolysed yeast protein or enzymatic yeast hydrolysate bait. The campaign was wholly successful, and over 700,000 acres were sprayed. The fact that malathion could be sprayed safely over inhabited areas made organisation of this vast eradication campaign much simpler and more effective than it might otherwise have been.

In Portugal, complete control of both adult olive flies and larvae entering the fruit has been obtained by three sprayings at fortnightly intervals with a mixture of 0.35 litres malathion emulsifiable concentrate, 2.0 kilos molasses, and 100 litres water.

Malathion is the only safe insecticide which comes near to providing the citrus grower with an all-round insecticide. It controls almost all kinds of scale, including soft scale, as well as mealy bugs, aphids, thrips, and the active forms of red mite. Its use should, of course, be considered as part of a regular pest control spray programme rather than as a panacea for dealing with pest outbreaks. The average rate of application when malathion is used alone is 1 pint of 50% emulsifiable concentrate or 2 - 2½ lbs. dispersible powder in 100 gallons water. Many growers use malathion in conjunction with a standard white oil emulsion, in which case the above amounts of malathion are cut by a half.

Both in the United States and Rhodesia malathion has proved highly effective for control of aphids attacking tobacco in seedbeds and on lands. Either one pint of 50% emulsifiable concentrate or 2½ lbs. of 25% dispersible powder is used per 100 gallons of spray per acre.

Malathion is used against other agricultural pests in Rhodesia. Against lucerne caterpillar, for instance, half a pint of 50% emulsifiable concentrate in 30 gallons water per acre gave quick kill of lucerne caterpillar without leaving residues dangerous to cattle subsequently feeding on the crop. The plant-eating ladybird, *Epilachna similio*, has been controlled by 1½ pints 50% malathion emulsifiable concentrate per acre.

Malathion is being increasingly used in East Africa to control antestia, the most serious pest of arabica coffee. Its safety and rapid action are points in its favour, coupled with limited persistence and a corresponding absence of interference with parasites and predators controlling mealy bugs and leaf-hoppers. Malathion also controls other coffee pests such as lacewing bug (*Habrochila*), thrips, aphids, scale insects, weevils, Lygus and leaf-eating caterpillars. It is normally applied from the ground but has also been applied successfully from the air to unshaded coffee at 2 gallons per acre of a 6% emulsion both experimentally and on a commercial scale. In the Belgian Congo, large quantities of DDT/malathion dust are used by African coffee growers for control of *Habrochila*. Belgian workers claim that DDT and malathion act synergistically against this pest.

Other uses for malathion in East Africa are control of the cereal aphids *Schizaphis graminium* and *Rhopalosiphum maidis* and protection of planting material from pineapple mealybug by dipping in 0.1% malathion emulsion for five minutes.

In temperate climates malathion has, of course, many uses. Aphids on root crops such as carrots, radish, and parsnip are well controlled by spraying with 1½-2 pints 50% malathion emulsifiable concentrate per acre, repeated if necessary. Aphids on strawberries in fruiting beds, runner beds, and on first-year plants are controlled by 1½ pints 50% malathion emulsifiable concentrate in 100 gallons of water. This spray is also recommended against red spider, especially near picking time.

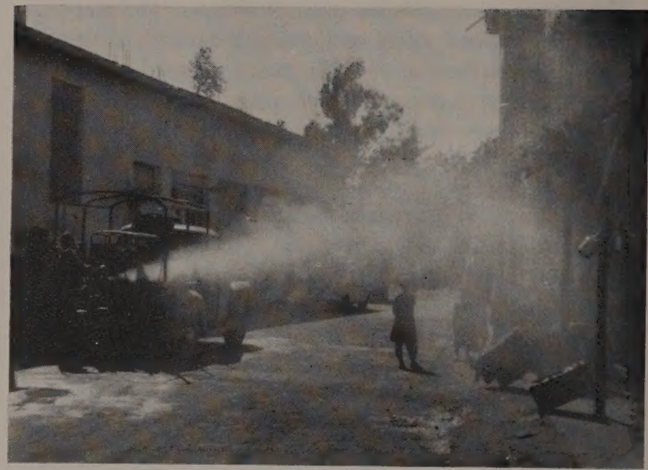
In a field trial in 1957 a range of insecticides was applied at 20 gallons per acre to beet infested with mangold fly and green aphid. Malathion at 15 ozs. active ingredient per acre gave better kill of mangold fly than demeton-methyl (meta-systox), but not so good as DDT, dieldrin or dipterex. Demeton-methyl was the only insecticide to give adequate control of aphids, but malathion gave approximately 65% control. For both pests the control achieved would probably have been better if a higher gallonage had been used.*

Excellent control of celery fly, *Philophylla hereclei*, has been obtained with malathion using 1½ pints 50% emulsifiable concentrate per 100 gallons spray. It gave much better control than DDT or dieldrin. It has been used for control of mites, thrips, and leafhoppers on blackberries, loganberries, raspberries, etc., and for control of mites, and phorid and sciarid flies on mushrooms.

Malathion will, of course, control many pests attacking fruit. Its use in South Australia where codling moth resistance to DDT was proved in 1953/54 is of exceptional interest. A number of insecticides including lead arsenate, endrin, methoxychlor, chlorthion, parathion, and diazinon were tried. Malathion at 0.05% and diazinon at 0.1% gave the best results. Diazinon caused mild leaf drop on Rome Beauty and ringspotting of London Pippin. Malathion caused neither fruit nor foliage injury. In view of the low toxicity of malathion and the excellent control obtained, it was recommended for use at 0.05-0.075% applied at intervals of 14 days beginning at petal fall and continuing until the danger of codling moth had passed.

In the United States, malathion is recommended against boll weevil which is their most damaging pest of cotton in areas where the weevil has developed resistance to chlorinated hydrocarbon insecticides. It is also recommended against hard-to-kill weevils from late season hatches in July and August. The rate of application is 1-3 lbs. actual malathion per acre in the form of either dust or emulsion spray. Malathion is also effective against many other cotton pests at ½ lb. actual malathion per acre — spider mites, aphids, leafhoppers, leafworms, thrips, white flies, lygus bug, etc., but not boll worm.

* *Personal communication from R. A. Dunning.*



Control of flies by fogging with malathion.

Phytotoxicity

Malathion is well tolerated by most plants at concentrations used for insect control and, in this respect, has a very good record. It should not be used on petunias, crassula, ferns, sweet peas, antirrhynums, and zineas.

Residues on Crops

Malathion is not a persistent insecticide and most crops can be sprayed, if necessary, within seven days of harvest. Ten days after application, malathion residues are usually less than 1 ppm. In this connection, it is worth bearing in mind that white rats fed for two years on food containing 1,000 ppm malathion were as normal and healthy as rats eating the same insecticide-free diet over the same period.

Malathion has been extensively used without any evidence of tainting foodstuffs.

Control of Stored Products Insects

Only a limited number of insecticides have been adopted for control of insect pests infesting stored products, the most important being DDT, lindane and pyrethrins, with or without the addition of synergists. Malathion is now coming into commercial use and there is every indication that it will be increasingly employed against stored products insects. The low toxicity of malathion is, of course, a most important factor in its favour as an insecticide for control of insects infesting foodstuffs and residues are unlikely to present a problem. In Canada and the United States, a tolerance limit of 8 ppm in small grains has been established. Dr. E. A. Parkin, in a recent paper read at the fourth International Congress of Crop Protection, mentioned experiments in which samples of maize taken from a bag stack three months after treating each layer of bags with malathion dispersible powder at 50 mgms. per sq. ft. were analysed. No malathion could be detected in the grain.

Malathion, which acts both as a contact and respiratory poison, is effective against a considerable range of insects commonly found to infest stored products, including such important pests as:—

Grain weevil	*Calandra granaria.*
Rice weevil	*Calandra oryzae.*
Saw-toothed grain beetle	*Oryzaephilus surinamensis.*
Drug store beetle ..	*Stegobium paniceum.*
Rust-red flour beetle ..	*Tribolium castaneum.*
Cigarette beetle	*Lasioderma serricorne.*
Lesser grain borer ..	*Rhyzopertha dominica.*
Khapra beetle	*Trogoderma granarium.*
Rust-red grain beetle ..	*Laemophloeus ferrugineus.*
Cacao moth	*Ephestia elutella.*
Dried fruit moth ..	*Ephestia cautella.*
Indian meal moth ..	*Plodia interpunctella.*

Malathion is particularly effective against *Tribolium* and *Oryzaephilus* and is the best insecticide suitable for stored products pest control tried to date for control of *Trogoderma.* Against this latter pest its toxicity, determined by topical application is much higher than that of lindane, DDT, or dieldrin. It produces rapid knockdown of adults although they die slowly. Experiments carried out at the DSIR Pest Infestation Laboratory in which malathion was added to grain indicate that newly emerged adults or eggs or young larvae must be very susceptible to malathion although mature larvae were not so easily killed. Australian spider beetle, *Ptinus tectus*, is resistant to malathion.

In the United Kingdom, the Ministry of Agriculture, Fisheries and Food recommends the use of malathion for control of stored products pests in the following ways:—

(a) by admixture with raw unprocessed grains and oilseeds, provided the dosages do not exceed 10 ozs. of malathion (for example, 60 lbs. of 1% dust or 2 gallons of 3% emulsion) per 1,000 bushels;

(b) by addition to the surface of bulk grains or oilseeds, provided the dosages do not exceed 5 oz. of malathion (for example, 30 lbs. of 1% dust or 1 gallon of 3% emulsion) per 1,000 sq. ft. of surface;

(c) by application of an emulsion or suspension of malathion in water on:

(i) the surfaces of stacks of raw grains and oilseeds contained in closely woven sacks of jute or similar fabric, provided the dosage does not exceed 114 mgms. malathion per sq. ft. of surface;

(ii) the walls and other surfaces of storage rooms where foodstuffs do not normally come into contact with treated surfaces;

Mist-blowing experiments with malathion for control of leaf-hoppers.

(iii) the walls of empty wagons and storage bins used for raw grains and oilseeds, and

(iv) the surfaces of stacks of foodstuffs in containers of wood, fibre board and similar materials.

A suspension or emulsion of 1.5% malathion is usually used for spraying surfaces at an application rate of 1 gallon per 1,000 sq. ft. of surface, but this may be increased to 2% without exceeding the permitted figure of 114 mgms. malathion per sq. ft.

In America, the United States Department of Agriculture recommends admixture of malathion emulsion or wheat flour malathion dust as grain is loaded or turned into final storage for protection of wheat, oats, rice, corn, rye, barley, grain sorghum, peanuts, and field or garden seeds, etc., against confused flour beetle, rice weevil, grain weevil, saw-toothed grain beetle, flat grain beetle, red flour beetle, rusty grain beetle, lesser grain borer and

Indian meal moth. For protection of stored grain from Indian meal moth, malathion dust or spray may be applied to the surface of clean or uninfested grain, and the treatment may be repeated if necessary. For residual spraying of walls, floors, and other surfaces of warehouses, railway wagons, ships' holds, grain elevators, etc., application of a 2% malathion emulsion is recommended after thorough cleaning. Under the quarantine regulations of certain States, malathion sprays are recommended for control of Khapra Beetle.

The Canadian Department of Agriculture recommends spraying empty granaries with 3% malathion emulsion at 1 gallon per 1,000 sq. ft. prior to grain storage. The addition of 0.5% malathion dust with a low grade flour carrier at 1 lb. per 10 bushels of grain is recommended for control of rusty grain beetle, grain mite, grain weevil, confused flour beetle, saw-toothed grain beetle, and Indian meal moth. For control of these pests in large storage bins where prolonged storage is anticipated the malathion dust should be applied to the surface of grain at one pound per ten bushels of grain in the top six inch layer and should be spread over the top of the grain and worked into a depth of six inches by means of a rake.

In the above recommendations, the use of premium grade malathion is usually specified and it is advisable to use premium grade formulations whether as emulsions, suspensions or dusts, when taking measures against stored products insects.

Control of Household and Public Health Pests

Malathion has proved a valuable insecticide for use against a number of domestic and public health pests, especially where they have developed resistance to the chlorinated hydrocarbon group of insecticides. Cockroaches, bed bugs, silver fish, firebrats, fleas, ants, spiders, earwigs and clover mites are among the household pests controlled by malathion. Against these pests 3% malathion is recommended either as an emulsion in water or as a solution in odourless kerosene. For use in homes, restaurants, kitchens and similar places, premium grade formulations will naturally be preferred. Application should, as always, take into account the habits of the insect causing trouble. In the case of bed bugs, a 1% solution of malathion in odourless kerosene should be generously applied to all bug harbourages whilst mattress surfaces may be lightly misted with the same solution. Care should be taken, of course, when controlling household pests not to contaminate food or cooking utensils. The clover mite, *Bryobia praetiosa*, is sometimes a nuisance in newly built houses and blocks of flats, and cannot be controlled effectively with DDT, BHC, dieldrin or chlordane. Trials carried out in England by Mr. Gradidge of the Pest Control Division of the Ministry of Agriculture lead to the application of malathion sprays (10 ozs. malathion wettable powder per gallon of water) being recommended for clover mite control. Malathion has been recommended in the United States for control of carpet beetles and clothes moth larvae.

Malathion can be used in a number of ways to control houseflies, both normal strains and those which have developed resistance to DDT, dieldrin and other chlorinated hydrocarbon insecticides. Its use, however, should always form part of a general anti-fly programme based on good sanitation. For control by residual spraying 1-1½% malathion should be used in the form of an emulsion or suspension applied to places where flies congregate or alight, such as walls, ceilings, fences, window sills, around refuse bins, etc. The spray should be applied so as to wet surfaces thoroughly without making them running wet, i.e., about one gallon of spray per thousand square feet. In the United States the addition of 10 lbs. sugar or 1 gallon of unsulphurised molasses to 50 gallons of spray is frequently recommended and is said to increase the persistence of the deposit, but there would appear to be a danger of surfaces sprayed in this way becoming sticky and collecting dirt and, possibly, encouraging growth of moulds. The residual action of malathion against flies is not very long being, on the average, about three weeks. Malathion, mixed with sugar or molasses, can also be used as a liquid fly bait applied to floors and ground where flies are seen to congregate, either with a coarse sprayer or with a watering can. Dry fly baits can also be used, and provide a very convenient means of dealing with flies.

Malathion is also used effectively for treating areas where flies breed. Application to breeding grounds of drenching emulsion sprays containing 1-1½% malathion is recommended and, again, in the United States the addition of sugar or molasses is usually suggested. Experiments in this country on a refuse tip infested with DDT-resistant flies proved the effectiveness of malathion when sprayed daily. The addition of sugar or molasses did not make the spray residue so attractive that it drew flies from normal refuse, but it did increase the effectiveness of the film since flies, once they settled, remained to feed and stayed longer in contact with the insecticide.

The use of malathion for actually killing fly larvae or maggots in breeding material has also been reported, and kills approaching 100% have been obtained. Dosage rates, however, are high, being of the order of 200 mgms or more per square foot.

Flies, mosquitoes and other flying pests can be killed with space sprays containing 2% malathion to which a knock-down agent, such as pyrethrins, can be added if desired. It must be remembered, however, that malathion is not freely soluble in paraffinic distillates, such as odourless kerosene, and auxiliary solvents need to be added. Malathion concentrates for making space sprays and fog solutions which overcome this difficulty are,

however, on the market. For fogging to control flying insect pests 2-5% solutions of malathion are used and dispersed with machines such as Swingfog and TIFA. Ready-for-use fog solutions formulated especially for this type of equipment can also be purchased.

Malathion is useful for control of mosquito larvae, especially those of culicine mosquitoes and of genera which have developed resistance to DDT, etc. Either emulsions or oil solutions can be used, and application can be made by spraying from the ground or from the air. About ½ lb. actual malathion per acre should be applied. Malathion may prove toxic to some species of fish, especially in shallow water.

Malathion is not generally recommended for control of adult mosquitoes by residual spraying, but in tests on plywood panels and in animal baited huts sprayed at 100 mgms. malathion per sq. ft. excellent kills of *Anopheles quadrimaculatus* were obtained over a period of 4-6 months.

Control of Livestock Pests

Malathion has been extensively tested for spraying, dipping and dusting animals including cattle, sheep, dogs, pigs and poultry, and has proved a safe and efficient material for destroying numerous external parasites such as lice, ticks and mites. To ensure maximum effect against parasites and freedom from harmful effects on the animals, only formulations especially prepared for veterinary use by firms specialising in this field should be employed. Malathion is particularly interesting for control of parasites which have developed resistance to insecticides commonly used for their control although, unfortunately, it appears to be expensive for control of resistant blue ticks on cattle raised under ranching conditions.

Also of great interest is the use of malathion for control of livestock pests which have proved difficult to control safely with other insecticides. For instance, it is used in South Africa for dipping sheep infested with Infectious Itch Mite, *Psorergates ovis.* Northern fowl mite, *Lyponyssus silviarum*, which is a very difficult pest to control can readily be dealt with by spraying poultry houses with 0.75% malathion emulsion or suspension, or by applying 1 lb. of 4% malathion dust per 50-60 sq. ft. of litter and floor space. Other poultry pests such as red mite, lice, and ticks are also readily controlled by malathion.

Chemical Treatment of Bracken (*Pteridium aquilinum*) in Scotland*

I. A Method of Measuring the Effects of Treatment.

By Elsie Conway (*University of Glasgow*).

AMONG the special problems presented by the Common Bracken Fern (*Pteridium aquilinum*) is the difficulty of evaluating the effects of treatment. The usually accepted method of assessing frond number and height in the year after treatment, though convenient, gives little idea of the actual impact of the treatment on the organs of growth and extension. The fronds are, in any case, seasonal and transitory growths; and it is the massive, spreading, underground (and therefore well-protected) stems, from which the fronds arise, that should be the real centre of attack. To understand the value of any form of treatment, then, it is necessary to know what is happening to this underground stem. In an established stand of bracken the stem consists of a tangled mass of secondary branches, which does not easily suggest any method of statistical or other analysis.

When a unit area of bracken land is dug up, a mass of rhizome consisting of various lengths of the underground stem can be taken out, and the stem is then seen as a storage organ carrying considerable amounts of carbohydrates which can be drawn on for further growth and frond production. The theory that these stores would be so depleted by frond-removal that the storage organ would shrivel and die is not borne out by actual trial: the food-stores are apparently so massive that they can withstand successive frond removal for long periods. The basic effect of mechanical frond removal is the initiation of large numbers of small frond-initials, any one of which may establish a new centre of growth. Thus, starvation by frond-destruction, whether effected by mechanical or other means, may be a very prolonged and not very rewarding project.

Further examination of the rhizome mass of field bracken shows that it is composed of a large number of secondary branches, each with a large apical region which is the area both of frond initiation and of extension. Among these branches, three types may be distinguished: (a) current year fronds arise on branches, each of which has a secondary stem apex a few cms. beyond the frond-base. In the late summer, these stem tips carry frond-buds—one or two at each tip—which will form the frond-population for the following year. These branches are mostly running through the upper levels of the soil. (b) Other stem branches, also found for the most part in the upper soil levels, are associated with fronds older than the current year: while some of these stem tips are secondary shoots which have gone through one year of dormancy, others may be older; but all are able to show the developing frond-buds and stem tips just as in current year shoots. A proportion of the frond-population in any year comes from such branches which have gone through a period of dormancy. Conditions that induce or break such dormancy are at present unknown; but undoubtedly these periods of dormancy add to the resistance to attack by the plant and its ability to restart growth by activated normal secondary branches (c) Thirdly, below the upper soil level branches (a) and (b) lie thicker, outward spreading stems with long internodes and considerable starch reserves. These fork at infrequent intervals and fronds are infrequently initiated at their apices. These branches, with their massive food reserves, give the plant considerable resistance to most forms of attack. Under certain stimulation, they give off branches that act as types (a) or (b).

For purposes of evaluation, branches of the type (a) and (b) may serve as units; the state of the stem apex and the adjoining frond-bud or buds can readily be assessed, and their behaviour before and after treatment readily analysed.

State of Branch Apices in Untreated Bracken

Examination of branch apices (a) and (b) above in the West of Scotland suggests that the apex of a secondary stem becomes active about the end of June and the initiation of a frond-bud becomes visible late in July. Growth of the stem appears to slow (but not necessarily to stop) during the early part of the autumn, while that of the frond-bud or buds which it carries continues markedly for a time. These observations are in general agreement with the description for the behaviour of the bracken in Breckland, Cambridgeshire, described by Watt.[1]

The following points may be emphasised:

(1) In the early autumn, the branches of the bracken stem running near to the soil surface are in an active state with a large frond potential already formed for next year. In the areas examined, remarkably little dead material was present among the upper branches, and the great majority were in a healthy and even active state.

(2) The number of frond-buds ready to expand in the succeeding year is very high by the end of September. A number of the stem apices were seen to carry more than one frond-bud, this being true of about 25% of the stem apices at the bases of current year fronds and 33% of stems associated with fronds older than the current year. This suggests a higher rate of frond initiation than that reported by Watt.[1] for the Breckland An earlier estimation,[2] of the ratio of frond-buds to expanded fronds taken in September on a number of West of Scotland sites showed ratios varying from 1.46 to 2.27. Since the number of expanded fronds remains more or less the same on an area, the high frond-bud potential means either that a large number are lost through frost or mechanical damage before they can mature or else that a considerable number remain in a dormant state below the surface of the soil. The latter might readily be stimulated to replace expanded fronds lost during the growing season. An excess of frond-buds is probably one of the features in the development of the plant, and observations made on sites in Perthshire, Stirlingshire and Dunbartonshire gave mean figures for ratios of frond-buds to expanded fronds as 1.93 in May (when the majority of the season's fronds were expanded above the ground) and 1.96 in September. Clearly, any chemical which had an inhibitory or damaging effect on frond-bud development would be an agent of active attack on the plant.

(3) The initiation of a visible frond-bud on the stem at the base of the current year's frond is not invariable: percentages varying between 5 and 35 of the apices without visible frond-buds were found in late September; while in the case of shoots associated with fronds older than one year, the proportion varied between 5 and 20%. Such stems might, of course, initiate frond-buds at a later time, though at the time of analysis they were not visible.

(4) Of the frond-population for next year, roughly two-thirds appear to be formed on stems immediately adjacent to fronds of the present year and one-third on stems older than one year. The period of dormancy which such stems can go through is so far quite undetermined.

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II. The Effects of Various Herbicides on Field Bracken (*Pteridium aquilinum*)

By J. D. Forrest (*West of Scotland Agricultural College*)

After reviewing chemicals Mr. Forrest discussed the general design of experiments and then said, relative to experimental results: " Application was made on the 17th August when the bracken was in a fully mature state. Four days after treatment all plots showed severe scorch. A rhizome analysis was carried out in October and there was no evidence of translocation which might have been revealed by damage to the stem apices or associated frond-buds. Samples were taken from the treated plots in early spring 1958 and it appeared that dalapon was inducing dormancy on the developing current year frond-buds. By June it was visually apparent that the frond density on the treated plots was much less than in the control plots. Counts were taken in June, July and August and it can be seen that with all treatments there was a retardation of frond emergence rather than an inhibition.

Reduction with dalapon and amino-triazole in the year after treatment

Treatment	% Reduction in Frond Density 1958		
	June	July	August
20 lb. Dalapon	76%	48%	26%
40 lb. Dalapon	90	68	15
20 lb. ATA	75	52	18
40 lb. ATA	92	78	10
10 lb. Dalapon+ATA	87	58	14
15 lb. Dalapon+ATA	91	71	7

In 1956 BORASCU 44 was applied to a plot of Drumclog Moor in Scotland. The photograph was taken two years later in 1958.

The fronds which emerged on the 20 lb./ac. and 40 lb./ac. plots were small and weak and varied in height from 6″ to 15″. Malformations of pinnae segments were noticeable. The creeping soft grass was apparently growing well and appeared unaffected by the dalapon. This may have been due either to the fact that there was a dense canopy of bracken at time of treatment or, as was suggested from the results of laboratory tests with plugs of various hill grasses, that creeping soft grass is moderately resistant to dalapon.

Single plot experiments in Argyll with dalapon at 20 lb./ac. 40 lb./ac. and 60 lb./ac. gave similar results both on rhizome analyses and reduction in density, with no real difference between the two higher rates.

On the 20 lb./ac. and 40 lb./ac. amino-triazole plots emergent fronds were chlorotic, with in some cases brown patches appearing on the bottom pinnae which gradually spread until the whole frond withered. The fronds were 12″-18″ high and tended to be taller and in a more mature state than on the dalapon plots. Other vegetation on the plots was severely affected and with the high rate of 40 lbs. the plots were practically bare.

The mixtures of the two seemed no more effective and in general the amino-triazole effect tended to dominate.

One year after treatment (Sept. 1958) a rhizome analysis was carried out on the emerged fronds from each treatment. No effect was discernible on the stem apices or associated frond-buds. It was noticed that all fronds from the treated plots showed severe rotting at the base of the stipe whilst this was not evident on the control. This effect could be due to treatment or to exposure through the weakened state of the frond and also the reduction in density.

General Conclusions

(a) *Non-selective herbicides*

Of the recent new non-selective herbicides only sodium borate at 4-8 lb./10 sq. yds. and sodium borate/chlorate and sodium borate +2,4-D at 2 lb.-4 lb. on 10 sq. yds. have given real control of bracken 18 months after treatment. In one case 8 lb./10 sq. yds. of sodium borate has given 94% control 2¼ years after treatment. Sodium chlorate applied dry by mechanical spreader at 300 lb., 400 lb., 500 lb./ac. gave over 97% control in frond density at least 1¼ years after treatment.

These non-selectives due to their high rate of application and present high cost would be impracticable to use for the control of bracken on a field scale. They would however be of use on forestry firebreaks or for " mopping up " areas which are inaccessible to cutting or bruising machines.

(b) *Selective herbicides*

ATA at 20 lb./ac. and 40 lb./ac. causes the next year's fronds to be later in emerging and invariably chlorotic. However all other vegetation is severely affected and it would appear that ATA shows little promise for the control of bracken.

Both dalapon and amino-triazole are translocated in the bracken rhizome and show frondular effects and reduction in density in the year after treatment though when rhizome apices are examined no formative effects are noticeable.

Dalapon at 20 lb./ac. and 40 lb./ac. also retards frond development and causes weak fronds to emerge with malformations on pinnae segments. In the trials carried out there was no lasting effect on the creeping soft grass.

This experiment is still under observance and cannot finally be assessed for at least another year. It appears that both dalapon and amino-triazole cause a reduction in density, though as the rhizome apices are unaffected any control obtained may last only a short period, and further trials are being carried out.

If chemical control of bracken is to be achieved on a field scale it is necessary to find a chemical which is selective, relatively cheap and gives a period of control better than the methods of defoliation used at present. Complete eradication may be ideal; but under present hill farming conditions is impracticable. It is probable that a relatively cheap herbicide giving 80% reduction in density for a period of 8-12 years would be acceptable. To most farmers once a chemical is found which can achieve this, there are other factors such as application of material and management after treatment which must be considered before it can be incorporated to the Scottish hill-farming system.

* *Abstract of lecture given to 4th British Weed Control Conference*

ORGANO-PHOSPHOROUS INSECTICIDES

ADVANCES in the insecticide field in recent years had been most rapid and spectacular in the sector of organo-phosphorous insecticides, comments Dr. A. H. M. Kirby, M.Sc., Ph.D., F.R.I.C. (East Malling Research Station), writing in the section "Control of Pests" in "Reports on the Progress of Applied Chemistry," Vol. XLII, 1957, and just published by the Society of Chemical Industry.

These advances are partly because of the extensive investigation carried out by pharmacologists and biochemists into the mammalian toxicity of many compounds likely to be of value in other fields. The serious problem of insect resistance to chlorinated hydrocarbon insecticides has been an important spur to studies in what, until the recent advances in the carbamate sector, has been the only alternative group of insecticides effective against a wide variety of insects and mites.

It is clear from recent reviews that toxic organo-phosphorous compounds are all inhibitors of esterases, and are reputed to act by anticholinesterase activity.

Evidence against anticholinesterase activity being the sole cause of toxicity of these compounds includes the fact that eggs of several insect species have been shown to die before hatching although the compound was applied before development has proceeded far enough for acetylcholinesterase to be present.

Dr. Kirby refers to experiments of Mehrotra and Smallman, who thought that this anomaly disappeared if acetylcholine itself was only present at an advanced stage of embryonic development. These workers used parathion and eggs of the common house-fly; this compound could easily persist for the 12 hours needed to complete development at the temperature used (28°C). Potter *et al*, however, applied the easily-hydrolised TEPP to eggs of *Pieris brassicae* L. and kept them at 15°, 7-8 days being needed for full development. Even so, most concentrations only prevented hatching, the embryos proceeding to full development in them for a week. Moreover, heavy doses of TEPP stopped development at an early stage, days before the presence of cholinesterase could be demonstrated. Pianka suggests that

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this might be due to a physical effect of the TEPP such as plasmolysis.

O'Brien and Spencer have shown that, although non-susceptible insects such as the cockroach oxidise schradan to a potent anti-cholinesterase, the latter is unable to reach the intact nerve cord; if the cord is damaged experimentally a high degree of inhibition can be induced. The same group have subjected permanganate oxidation products of schradan to counter-current separation, and conclude that the methylol derivative is the active anti-cholinesterase, the N-oxide being only transiently formed, if at all.

After reviewing other new work, Dr. Kirby refers to Krueger and Casida who have determined topical LD_{50} values for six insects, and the subcutaneous values for white rats, for fifteen organo-phosphorous insecticides. Paraoxin was the most toxic to rats and to 4 of the 6 insect species, and values for adult and/or larval stages of 27 insects were determined for that compound. Malathion showed the biggest difference between toxicities to insects and to rats, while schradan was much more toxic to rats than to any insect used except the pea aphid.

Infra-red studies by O'Brien on malathion and its isomer, *OS*-dimethyl *S*-(1 : 2-dicarbethoxyethyl) phosphorodithiolate, suggest that isomerization occurs on heating, and the isomer is a stronger inhibitor of cholinesterases and succinoxidases *in vitro* than malathion. The *in vitro* results favoured cholinesterase inhibition as the cause of death, but *in vivo* studies in the cockroach did not confirm this view.

Malathion has been shown to be involved in " potentiation " that is, greater toxicity to mammals of malathion plus EPN than the mere summing of the individual toxicities. Cook *et al* consider that detoxication of malathion in mammals is due to enzymic hydrolysis in the liyer of the succinat3eester groups, and they explain the "potentiation" by EPN and other organo-phosphorous compounds, especially diazinon, as an inhibition of this enzyme system by these other compounds, so that malathion remains and can be converted to a potent anticholinesterase.

Mr. M. H. J. Villeneuve, former head of the Chemical Section of the Commercial Development Department of Pfizer Ltd., the manufacturing chemists, has been transferred to Kemball, Bishop & Co., Ltd., as Technical Service Manager. This is a new post.

Kemball, Bishop & Co., Ltd., were acquired by Pfizer Ltd. in October.

CHEMICAL CONTROL OF BRACKEN

(*PTERIDIUM AQUILINUM*)

By M. J. EDWARDS and D. MONTGOMERY,

Borax Consolidated Limited, London.

Introduction

CHEMICAL ERADICATION of established bracken is not generally economic. There are exceptions in certain limited areas where, for example, bracken creates a problem of access or increases fire risk. Chemicals might also be used to prevent the spread of bracken on to cropland and to control it in young conifer plantations.

Where the object is to recover cropland, chemical residues are likely to be a difficult problem and mechanical methods of bracken control are to be preferred.

Many chemicals have been tested against bracken over the past twenty years. One of the most effective has been sodium chlorate used either dry or as a spray. Sodium chlorate was tested extensively in Scotland during the 1920's and 30's.[1] These tests and others show that 300 to 400 lb. per acre generally gives a 95% kill of frond growth for a season. However, the danger of fire from sodium chlorate and the associated risk of injury to the operator have to be considered. A combination of sodium borate and chlorate is much safer and of equal effectiveness since, as the work described later shows, borates cause considerable damage to bracken at comparatively low rates of application.

2,4-D and other growth regulating chemicals have been extensively tested on bracken[5] but they do not appear to damage the rhizome to any significant extent or even seriously prevent frond growth in mature bracken. Amino triazole has been tested in several countries and interesting results obtained in Norway where Bylterud[2] has reported control at low rates of application. The fact that similar results were not obtained in Scotland[5] is perhaps related to the strain of Pteridium.

Dalapon has been tried recently and although results have been variable it can give quite an effective frond kill. In trials carried out by the Agricultural Research Council in conjunction with the National Agricultural Advisory Service[6] application in July 1957 was followed during the rest of that year by scorching of the fronds; particularly at the highest dosage rate of 20 lb. per acre. A frond count about a year after spraying showed that this rate had given 75% or more reduction in frond density. Dalapon at such rates will not eradicate bracken but merely causes dormancy in the frond buds; possibly repeated applications will be more successful in controlling frond growth and further experiments are being carried out.

Among other chemicals tested but not considered worth further investigation are ammonium sulphamate, TCA and maleic hydrazide.[5] Observations made by one of the authors of this article indicate that simazin has little effect on bracken at high rates. On well established bracken monuron is not completely effective at rates as high as 50 lb. per acre.[3]

Early trials with borates on bracken were confined to calcium compounds at high rates in the Landes Region of France. They were very effective and prevented new growth for two years or longer.[7] However, the transport of large quantities of a bulky chemical over rough country is a problem.

In view of the relative lack of control from the herbicides reviewed above, it appeared that borates may be worth consideration at lower rates of application particularly in combination with other herbicides.

Recent trials with borate containing herbicides

During the last three years sodium borates have been tested on established bracken in the U.K. in different formulations with other active chemicals such as monuron, 2,4-D and sodium chlorate. The initial trials in 1956 showed that the best results were obtained with a straight concentrated borate ore (Concentrated BORASCU) containing 65% B_2O_3 or a pelleted combination of 2,4-D and sodium borate (DB Granular) containing 7·5% 2,4-D Acid and 39·3% B_2O_3. The rates of application used in initial trials varied from 7 to 10 lb. on 10 sq. yds. for Concentrated BORASCU and 1 to 4 lb. for DB Granular. After application in April 1956 all treatments prevented nearly all frond growth up to September 1957. On the plots treated with DB Granular, grasses (mainly Agrostis and Holcus spp.) became well established during 1957.

Typical bracken growth in front ride. Regularly cut once a year in late summer.

Same site at end of 1958 after DB treatment in Spring

Since these trials indicated that lower rates of application of both materials might be effective, further replicated trials were laid out using Concentrated BORASCU at rates of 1 to 6 lb. on 10 sq. yds. and DB Granular at ½ to 2 lb. on 10 sq. yds. These were established in April and early May 1958 on two areas of bracken in Wales. Strong epinasty was noticed on emerging fronds soon after application of the material containing 2,4-D. Rates of between 1 and 2 lb. of DB Granular on 10 sq. yds. and about 3 lb. of Concentrated BORASCU were effective in preventing frond growth throughout the year. To some extent soil type and pH influence the effectiveness of both materials. Concentrated BORASCU seems most effective in highly acid soils which are, of course, common in bracken infested areas. On four sites where trials were carried out over 1956-58, the pH was between 4.5 and 4.6.

In these trials the damage to rhizome buds appeared to be greater with Concentrated BORASCU than with DB Granular used at the rates noted above. It was observed that the lower layer of rhizome was often more severely damaged than the upper layer, probably due to leaching caused by the heavy rainfall in this area during the summer of 1958.

Other tests with similar formulations were run concurrently in different parts of the country. Some of these were carried out by the West of Scotland Agricultural College at Drumclog Moor, Dunbartonshire, and have been reported by Conway and Forrest.[4] DB Granular at rates of 2 to 4 lb. on 10 sq. yds. and a crude sodium borate ore—in this case containing only 45% B_2O_3—at rates of 4 and 8 lb. on 10 sq. yds. gave satisfactory control of bracken for eighteen months after treatment. The same results were obtained from a sodium borate — sodium chlorate combination (25% sodium chlorate, 73% sodium borate) used at rates between 2 and 4 lb. on 10 sq. yds. Forrest noted that in one case 8 lb. per 10 sq. yds. of the 45% sodium borate ore was still giving 94% control of frond growth two and a half years after treatment.

Timing of herbicide application is important in relation to rainfall and frond emergence. Other trials not described here showed that late summer or autumn application with borate containing materials does not give satisfactory results. Kill is slow and losses due to leaching over the winter months mean that effective control will not be obtained throughout the following year, particularly in areas of high rainfall. With DB Granular timing of application is important since a period of active growth combined with some rain is required for full effect. The various trials carried out show that the best time for DB Granular is just before frond emergence. With Concentrated BORASCU timing of the application during the spring months is not so critical. As indicated above, the length of control obtained with borates depends on rainfall and in most of the experiments described here the annual average was between 30″ and 40″.

During 1958 extensive commercial trials on about 50 acres were carried out on bracken infested land by Borax Consolidated Limited in conjunction with one of the Electricity Boards. Using DB Granular at 480 lb. per acre applied by hand operated spreader in April, all areas were showing at least 98% control of frond growth by the end of 1958. Excavations in November 1958 revealed a high proportion of dead or severely damaged rhizomes. None of the frond buds examined on the rhizomes appeared to be living.

Trials are in progress to determine how soon young trees may be planted safely in ground treated with borates at the above rates.

Importance of Method of Application

Because of the inaccessibility of bracken infested areas and attendant difficulties in supply and haulage of water,

application is often a problem. A material which can be applied dry by mechanical or power operated spreader and which is effective at reasonably low rates of application is the most suitable. Where spray application is essential, as with dalapon, low volume equipment is preferable.

Conclusions

(1) Concentrated sodium borate ore (Concentrated BORASCU, containing 65% B_2O_3) is an effective herbicide for bracken control at rates of 2 to 4 lb. on 10 sq. yds. Present indications are that 4 lb. (17 cwts. per acre) will cause extensive damage to both frond buds and rhizomes and will prevent most regrowth of bracken for up to two years. A sodium borate-2,4-D pelleted combination (DB Granular) is similarly effective at application rates of 1 to 2 lb. on 10 sq. yds. While reasonably consistent results were obtained, tests are in progress to determine in more detail the effects of soil texture, pH, organic content, rainfall and other factors.

(2) With Concentrated BORASCU the time of application is not a very critical factor though the optimum time appears to be just before the fronds emerge. In the case of DB Granular the best time for application is certainly just before frond emergence.

(3) Grasses, chiefly Holcus and Agrostis spp. usually become well established on treated areas twelve months after spring application.

(4) Dry materials such as those described can be economically applied by using a mechanical or power operated spreader.

Summary

Field trials carried out during the last three years show that a crude sodium borate (Concentrated BORASCU with a boric oxide content of 65%) applied dry during early spring gives a high percentage of frond kill on established bracken. The length of time for which regrowth is prevented depends on the dosage used, soil type and rainfall but results indicate that 3 to 4 lb. on 10 sq. yds. (13 to 17 cwts. per acre) prevents frond growth for two seasons while a lower rate of about 8 cwts. per acre gives satisfactory frond control throughout one season.

Similar results were obtained with a pelleted combination of 2,4-D and sodium borate (7.5% 2,4-D acid and 39.3% B_2O_3) applied at rates of 480 lb. per acre and over.

Both products caused extensive damage to rhizomes and attacked active and dormant buds.

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Suspected Sabotage at Trimpell Factory

Police and works security officers are investigating a case of suspected sabotage at the Middleton factory of Trimpell Ltd. which is run by I.C.I. Besides refining crude oil into petrol it produces fertilisers, ammonia, and methanol amounting in total to 250,000 tons a year. The general manager, Mr. Edward Beesley told *The Times:* "During the last few days the staff operating the large compressors which are used to produce high pressure gas for making ammonia and methanol detected that certain bearings were in a condition that could not be explained by normal plant operations. Had the circumstances not been discovered so promptly they could have led to serious damage. Because of the unusual incidents that could not be technically explained, an inquiry was deemed necessary."

Herbicides and the American Farmer *

By R. H. Beatty *

(*Director of Research, Agricultural Chemicals Division*)

Amchem Products, Inc., Ambler, Pennsylvania.

The need for herbicides in America—economic considerations

IT IS ESTIMATED that in the United States the cost of farm labour has increased 400% during the past 25 years. Even so, there are fewer and fewer men available for farm work. Because of this and other production expenses, the farmer's profit margin has become smaller and the need for increased efficiency more and more urgent.

The small family-operated farm in America is rapidly disappearing. To meet competition, farms have been consolidated into larger units permitting the use of mechanised equipment, which is essential to the big business most farming has now become. Chemical weed control has helped considerably in solving the problems of labour shortage and increased costs. Consider the Mississippi cotton grower whose labour requirements for mechanical weed control range from 20 to 41 man-hours per acre. The use of herbicides in cotton reduced this to about five man-hours per acre, and also increased yields somewhat, leading to an average gain of $21.00 per acre. The gains from controlling weeds chemically in rice are even more dramatic, running as high as $400.00 per acre in foundation stock commanding a premium price as seed.

The American livestock farmer has learned that spraying killed more weeds than did mowing.

The biological aspects of weed control were also becoming increasingly complex.

Another type of biological change that complicated the chemical weed control situation was the way changes in weed population occurred when ecological balances were upset.

The American farmer's acceptance of chemical weed control

We also know there is no substitute for good cultural practices, but the advantages of chemical weed control become apparent to more American farmers every year. We have now reached the point where more acres are sprayed for weed control than for the control of insects and diseases combined, said Mr. Beatty.

Today, many mid-Western farmers are buying a new type 6-row planter equipped with attachments for applying fertiliser, seed, soil insecticides and pre-emergence herbicide band treatment in one operation, all to reduce labour and insure a satisfactory crop.

Pre-emergence herbicide treatment

Most of the herbicides we are using on vegetables are applied pre-emergence to the weeds. Unfortunately, there are several rather rigid factors which determine the success or failure of pre-emergence treatment.

The pre-emergence herbicide must be tolerated by the crop, and most of the chemicals used must be present in lethal concentrations in the region where the weed seeds are germinating.

The complexities of soil texture and colloidal properties, and physical characteristics of the chemical affect the concentration and distribution of the herbicide. The work of Dr. G. F. Warren of Purdue University indicates that TCA and dalapon (2,2-dichloropropionic acid) are not held by the soil. The benzoics (2,3,6-trichlorobenzoic acid and related isomers) and CDAA (2-chloro-N,N-diallylacetamide, sold as Randox) are attracted to some degree. CIPC, pentachlorophenol and certain substituted urea compounds are absorbed in much larger quantities. Therefore, rates of chemical applied will vary with different soil types.

Moisture content of the soil at planting time and rainfall following treatment affect concentration and distribution, and these two factors are the cause of erratic results with several chemicals. Overhead or furrow irrigation as practiced by many vegetable growers can help correct this factor.

If the chemical is subject to rapid inactivation, then temperature, moisture, light, and soil microbiological activity will affect its weed killing properties.

When all factors are considered, we realise that pre-emergence chemicals are subject to many influences, several of which are relatively uncontrollable. I think it is essential for those of us who manufacture and recommend these chemicals to understand how these factors will affect results and to explain the conditions of success and failure to the farmer.

Mr. Beatty discussing granular herbicides, said that, " Four years ago, Dr. L. L. Danielson began a significant series of trials to investigate the possibilities of impregnating low cost and readily available granular carriers with active herbicides, he found that under his conditions pre-emergence application of CDEC (2-chloroallyl diethyldithiocarbamate, sold as Vegedex) on a suitable granular carrier such as attaclay or vermiculite controlled weeds as effectively as spray treatment. Results indicated that annual grasses, chickweed and henbit could be controlled by applying granular Vegedex immediately after planting spinach, kale, collards, turnip greens, mustard greens, cabbage, broccoli, cauliflower and Brussels sprouts did increase selectivity and sometimes produced better weed control."

Chemical weed control in beans, peas, onions, potatoes and other vegetable crops was discussed.

For cucumbers, muskmelons and watermelons, pre-emergence treatment with NPA (N-1-napthylphthalamic acid, sold as Alanap 3) is generally recommended. Vegedex is being used somewhat on cucumbers, and Dinoben looks promising on pumpkins and squash.

Mr. Beatty then considered in detail, new herbicide techniques and chemicals:

" Today, farmers seeing the wonders of 2,4-D, MCP, dinitros and other herbicides are asking research for more. They want chemicals with greater selectivity. They want chemicals which will eradicate perennial weeds but permit planting crops. They want pre-emergence chemicals which are more reliable," said Mr. Beatty.

Dalapon was definitely an improvement over the unreliable TCA for controlling Johnson (*Sorgum halepense*), Bermuda (*Cynodon dactylon*), and quackgrasses.

Amitrol's outstanding contribution was its excellent control of Canada thistle, whitetop, horsetail, poison ivy, cattails (*Typha latifolia*) and other perennial broadleaf weeds. It was absorbed and translocated rapidly and its apparent persistence in the plant often produced delayed or prolonged reaction.

The substituted urea herbicides were a versatile and accepted group of compounds. Monuron and diuron were being used as soil sterilants at rates of 20 to 80 pounds per acre alone, or combined at reduced rates with chlorates, borates, TCA and other chemicals.

The introduction of 3-phenyl-1,1-dimethylurea (*fenuron*) is making possible a new approach to selective brush control, that of root absorption from pelleted material applied by airplane. The chemical has been used commercially to remove blackjack oak (*Quercus marilandica*), post oak (*Quercus stellata*), and winged elm (*Ulmus alata*) from rangeland in Texas without serious injury to the native grasses, but cost and some biological problems must be solved. Use in other areas is anticipated.

1-*n*-butyl-3-(3,4-dichlorophenyl)-1-methylurea (neburon) has a very low order of solubility. It is being accepted by our nurserymen for control of annual weeds in ornamental narrowleaf evergreens, by our greenskeepers for control of common and mouse-ear chickweed (*Cerastium vulgatum*) and shows promise for annual weed control in seedling alfalfa, tomatoes and strawberries.

CDEC and CDAA were two closely related new chemicals which killed germinating weeds.

AMCHEM had recently introduced an interesting new group of chemicals, 2,6-dimethyl phenyl chloroacetamide and related derivatives, which had shown promise in limited tests for the selective control of wild oats in wheat and it was understood that promising results on wild oats had been obtained with a Spencer Chemical Company material identified only as S-847, and others were also being tested.

" From Switzerland, Geigy Chemical Company introduced to the American farmer a much-needed chemical —simazin. This herbicide, originally used as a soil sterilant, has shown outstanding ability to control annual grasses and broadleaf weeds in corn. For this purpose, it has exhibited the greatest selectivity I have ever seen. This year, simazin was sold on a limited scale to corn growers in the Mid-West. Unfortunately, in certain areas the soil was extremely dry at planting time and for at least a month afterwards. Under these unusual conditions it was found that, contrary to the experience of

previous years, simazin's effectiveness is related to soil moisture or other factors. However, these are not as critical as with 2,4-D DNPB or other pre-emergence herbicides. Where conditions were more nearly normal and farmers used the recommended rates, simazin's performance was outstanding," observed Mr. Beatty.

Discussing the butyrics, Mr. Beatty said, "The American farmer will soon benefit from the fundamental research of Dr. Wain and his group at Wye College. Because of the extensive work you have done with the butyric compounds, I will not take the time to discuss rates and weeds controlled. In 1959, 4-(2,4-DB) will be sold in the United States for use on alfalfa, red and white clover and birdsfoot trefoil grown for seed. The Federal Government will require studies before 4-(2,4-DB) can be recommended for use on these crops grown for feed.

Because annual grasses are often a problem in establishing legumes, 4-(2,4-DB) will be recommended in combination with dalapon or TCA for use in alfalfa and birdsfoot trefoil plantings.

I am sure that once our farmers see the selective properties of these chemicals, they will want to use them for pure stands of forage legumes grown for hay and for weed control in cereal crops under-seeded with certain legumes."

EPTC (sold as Eptam) had been tested extensively during the 1958 season. Results of pre-emergence spray applications to the soil were somewhat variable, depending on soil moisture, physical properties, temperature, rates and other factors.

The herbicidal effectiveness of chlorinated benzoic isomers had been demonstrated during the past several years and 2,3,6-trichlorophenylacetic acid, introduced to certain research workers last year by Hooker Chemical Corporation, provided a good example of a major development resulting from investigating ring substitutions. This was a most interesting chemical.

Dinoben and Amoben

AMCHEM became interested in the selectivity properties of the benzoics and had developed two related pre-emergence chemicals with good crop selectivity which control a wide range of annual weeds. These materials were also the result of investigating ring substitutions.

"Dinoben (3-nitro-2,5-dichlorobenzoic acid) is much more selective than the parent compound, 2,5-dichlorobenzoic acid. Asparagus, carrots, corn, lettuce, flax, peas, potatoes, squash and peppers tolerated a 4-pound-per acre pre-emergence treatment which controlled annual grass and broadleaf weeds for 6 to 8 weeks.

"Amoben (3-amino-2,5-dichlorobenzoic acid) seems to be a more effective herbicide and in addition to the crops just mentioned, shows greater tolerance by soybeans. Four pounds of Amoben applied pre-emergence to the crop gave excellent seasonal control of annual broadleaf weeds and grasses without injuring soybeans in tests at Ohio State University and on our company farm in Pennsylvania."

"I am sure most of you have heard something about inverted emulsions of the phenoxy acids, particularly brushkiller formulations which my company has been investigating in the United States. We have been working with inverted esters, oil-soluble amines and acids of the phenoxyacetics. When the formulations are mixed with oil and water in various proportions, a viscous material similar to buttermilk or mayonnaise is produced. In our research we have attempted to evaluate these new formulations with regard to drift characteristics, herbicidal activity and marking properties.

To study these factors in relation to viscosity of the material, our engineering group developed a centrifugal sprayer with which we could vary volume and droplet size, and distribute very viscous materials which cannot be sprayed from conventional equipment.

It is too early to draw definite conclusions, but we are pleased with our new sprayer and the invert emulsions when applied by helicopter or fixed-wing aircraft. Seven gallons total volume per acre applied from a helicopter seems to be a good marker. When the material was applied from altitudes necessary to clear the steel towers which appear on rights-of-way, the material and sprayer reduced drift. We have applied the material satisfactorily at wind velocities well over the present 5-mile per hour limit. With regard to herbicidal activity, the material appears to equal conventional sprays on most species, and is superior in translocating properties on mesquite. Control of several hard-to-wet water weeds, such as water lettuce (*Pistia stratiotes*), looks encouraging with this new formulation."

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* *Abstract of lecture given to the 4th British Weed Control Conference.*

ATOMS FOR PEACE—

AND

PESTICIDES?

In Brookhaven's "atomic garden" seeds and growing plants are subjected to gamma radiation from radioactive cobalt suspended from a pole in the centre of the garden. The closer the plants are placed to the cobalt, the more intense is the radiation they receive.

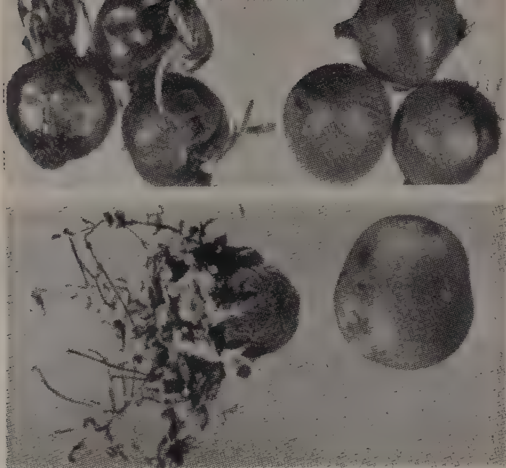
A DEVELOPMENT about which it is well for the industry to know, especially on the research side, is the harnessing of atomic energy to assist in pesticide developments. Some of these applications may not mature for a dozen years or more—on the other hand so rapid is the rate of man's domination over the atom that what may be thought of as a reasonably long-term programme may be "just around the corner." Who knows?

It is, therefore, in the spirit of keeping the Industry abreast of developments that we review some of the work being done in this field in the U.S.A.

At Brookhaven National Laboratory, for instance, Long Island, a major centre of research by the U.S. Atomic Energy Commission, work on nuclear and related sciences is proceeding apace. One of the Laboratory's powerful atom smashing machines, the Cosmotron, so named because scientists for the first time were able to impart to nuclear particles energies equivalent to those of cosmic rays, operates at energies as high as 2,300 million electron volts: but even this will be dwarfed by a new "atom smasher" now being built, and designed to operate at 25,000 million electron volts, close to the energies inherent in natural stable atoms.

Brookhaven scientists are now studying the effects of radiation on plants and animals and are also using radioisotopes to follow the course of life processes. They have already produced useful mutations by subjecting growing plants to gamma radiation in an "atomic garden" or irradiating seeds in the thermal column of a reactor. When mutations are produced, those with desirable qualities are picked out, and eventually it is possible in some cases to obtain improved varieties.

The atom is also helping the farmer in a number of ways. Radioisotopes are being used in studies on crops' improvement, soil chemistry and farm animals. Mutations which may be useful have been induced by radiation in crops such as apples, grapes, tomatoes, grain, maize, peanuts and soyabeans. In soil chemistry researchers are tracing the movement and uptake of essential minerals by soils and plants and are investigating the value of fertilisers and growth hormones. Research on farm



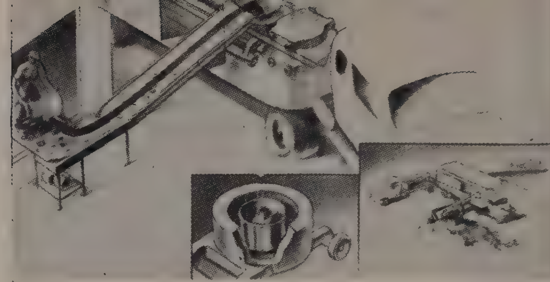
Onions and potatoes are among the foods which atomic energy can successfully preserve. These onions are seven months old. The unsprouted ones were "cold sterilised" by radiation. Both potatoes are nearly two years old. Atomic preservation has kept the one on the right in perfect condition.

animals includes physiological, metabolic and nutritional studies, and investigation of livestock diseases. Radioisotopes are also providing knowledge which is assisting farmers to control pests, parasites and weeds. These atomic tools are already giving impetus to the technological revolution in agriculture and should lead to higher farm output, more flexibility in the crops and animals produced and to more varied diets at lower costs.

The use of radiation, too, to destroy insects which infest stored grains and delay the germination of certain crops like potatoes and onions, is a rapidly-expanding application. The preservation of food by radiation is potentially one of the most beneficial uses of atomic energy. Progress has already been made in delaying the spoilage of perishable foods. Research is now being intensified to tackle problems which must be solved before the technique can be commercially adopted. Tests have shown that atomic-treated foods are nutritious and safe but some have a poor flavour and unpleasant smell. These difficulties, however, may be expected to be surmounted eventually, and when they are, a preservation process will be available that may revolutionise food storage and distribution.

It is interesting to note that scientists claim to have produced disease-free peanut plants which give a 30 per cent. higher yield by irradiating seed and then selecting plants which showed favourable mutations for further breeding.

The use of radio-active fertilisers also is assisting considerably in helping scientists: some are applied at planting time and a portable counter ensures that radioactive material is covered completely with soil: injections of radioisotopes to fruit, such as tomatoes, and the use of a Geiger counter to detect radiation as the fertiliser moves through stems and leaves is another research approach.



Mobile sterilisation units like this may in future be able to process food crops in fields at harvest time. As the food is fed into the truck it moves past a radiation source (centre inset which kills instantly all spoilage bacteria)

Plants raised from seeds irradiated at Brookhaven often show changes which are utilised to develop new plant species. As a result of atomic mutation the bundle of wheat shown on the left is free of rust. It was grown on a plot adjacent to the bundle on the right, which is considerably affected by rust.

Screw-worms, which infest the wounds of livestock, have been eliminated from an area in the Caribbean Islands by atomic radiation. Male flies were made sterile and dropped from planes to mate with female flies. As the female mates only once, no offspring were produced from the matings with irradiated flies.

Richardson & Starling, Ltd., Timber Decay Specialists, take delivery of their new fleet of technical surveyors' cars.
All cars are renewed annually by arrangement with Messrs. Henlys Limited through their Winchester Subsidiary, Messrs. Wessex Motors Limited.

A chemical weedkiller which can destroy grass and weeds, is to be marketed in 1959 by Shell Chemical Company Limited. "Shell Total Weedkiller" is based on Simazin, a chemical which has extremely good persistence, is non-toxic, non-corrosive and non-inflammable.

This weedkiller is absorbed by the roots of the weeds and is easy to apply as a spray. Best results are obtained when the weedkiller is applied just before plant growth starts in the Spring. An even coverage of the ground is then possible without the obstruction of a canopy of weed growth, and less dead vegetation is left behind. Once the weedkiller has been applied, results will be apparent three to six weeks later. The ground will then be free of weeds for twelve months, after which a maintenance dose is recommended.

The product has the advantage of not leaching out, which gives it its very good lasting effect. Another advantage claimed for the product is that it will not "edge" or creep from the sprayed area on to nearby plants or lawns.

Apart from use on farms and in gardens, "Shell Total Weedkiller" can be effectively applied to clear building sites and other public places under municipal care. Building sites can be cleared before work starts and then kept weed free by yearly maintenance doses.

"Shell Total Weedkiller" is a wettable powder and is sold in 5 lb. tins or 56 lb. drums. It can be applied by normal high volume spraying equipment possessing agitation, or on small areas by knapsack sprayer or watering can.

Pest Repelling

"Every day we read of new and deadlier sprays being put on the market, capable of killing almost every form of insect life and sometimes endangering human and animal life as well. Only a fanatic would suggest that, under modern conditions of agriculture and horticulture, insecticides are unnecessary, but at the same time there is a feeling that we sometimes go too far. Many insecticides kill the natural enemies of the noxious insects with the result that in the following season the pest problem is worse than ever," state Chase Protected Cultivation Ltd.

"Therefore, there is a very good case for *repelling* pests instead of killing them." Chase Protected Cultivation Ltd. have been experimenting on these lines for several years. They now have two products on the market incorporating this principle.

The first is "Sea Magic," sold primarily as a foliar spray for feeding the plant through the leaves, and based on seaweed. A small proportion of particular land-plant tissues has also been incorporated and this, in addition to "balancing" the product nutritionally, acts as a powerful repellent to many sucking insects, particularly the various types of aphides. It is not claimed that an application of "Sea Magic" will give the 100% kill which can be obtained by using some chemical poison sprays, but instead it will protect the plants from attack by the pests.

The second product is a mouse-repellent which is being applied, to garden pea seeds and sweet pea seeds sold as Chase Compost Grown. This has given excellent results in controlled tests. "Unlike a poison bait, it prevents the mouse from touching the seed instead of killing it after it has eaten the seed, which latter is little consolation to the average gardener unless he is a particularly vindictive man! In addition to being a mouse-repellent, the product is also a growth stimulant. It is not sold by itself, but the treated seeds are on the market for the first time this year," the company observes.

Land 4. Winter 1958-9.
Published by Shell Chemical Company Limited, 170 *Piccadilly, London, W.*1.

This Farm Journal of Shell Chemical Company contains articles, photographs and coloured reproductions, all of a high standard and calculated to be of interest to the countryman.

NEW PUBLICATIONS

Bureau of Chemistry State of California, Department of Agriculture. " Acreages Treated for Agricultural Pest Control by Counties in 1957."

Published by State of California, Department of Agriculture, Sacramento, 14, *California, U.S.A.*

There are some interesting statistics contained in this duplicated announcement PC-114.

The total acres treated by aircraft in 1957 was five per cent. less than the total for 1956, and marks the first year without an annual increase since 1950. Despite the slight reduction the figure for 1957 represents the equivalent of nearly one-half of the total crop land of the State.

The figures show three major changes compared with 1956: (1) Thirty per cent. less alfalfa and clover treated by aircraft, (2) a large increase in total acres of grapes reported treated with dusts and sprays, and (3) a large increase in range and pastures treated. The drop in alfalfa and clover acreage can be attributed to the introduction and establishment of parasites for the spotted alfalfa aphid, to the increased use of ground rigs in control of this pest, to the decrease in acres of alfalfa grown and to the use of resistant Lahontan alfalfa for new fields. Increase of range and pasture treatment is apparently due to grasshopper outbreaks in 1957.

British Wood Preserving Association. 1958 Convention Record.

Published by British Wood Preserving Association, 6 *Southampton Place, London, W.C.*1. *Price to non-members* 12*s.* 6*d. post free.*

A well-produced volume which, as the name indicates, contains copies of the papers presented at the 1958 Convention of the Association together with reports of the discussions on the papers.

Publications such as these are invaluable as a permanent record and non-members will find this publication good value at 12s. 6d.

The papers even for those who attended the Convention, are worthy of re-reading and study and research workers in this field would do well to ensure that this volume is on the bookshelf for handy reference.

Agricultural Weedkillers.

Published by May and Baker Ltd., Dagenham, Essex.

This is the third edition, just published, of great value to users. Formulations, spraying techniques, treatment of individual crops, weeds and brushwood control are all listed and there is also a table of application rates.

This edition runs to 95 pages.

Selective weedkillers for Weed Control in Grassland.

Published by May and Baker Ltd., Dagenham, Essex.

The first edition and what is in effect a handbook in respect of 1959. Within the scope of 34 pages a great deal of specialised information has been condensed, including illustrations.

Treatment of individual types of grassland and notes on individual weeds are two important chapters as well as one on application rates.

Modern Farming. Volume 28.

Published by Boots Pure Drug Co. Ltd., Station Street, Nottingham.

One article, " Trends in Danish Farming, 1958 " gives an international flavour to this booklet but " Method and Your Management " may be of more direct interest.

Also included is a *leaflet* relative to sheep dips.

" Ceresan " WB.

*Published by Bayer Agriculture Ltd., Thorneycroft House, Smith Square, London, S.W.*1.

A leaflet relative to treatment of Wheat Bulb Fly by " Ceresan " WB.

The manufacturers of this product comment:

> " Following this year's disastrous harvest, the acreage already sown to winter wheat is far less than would normally be the case in mid-November. For many farmers there is no alternative now to the planting of spring varieties, but if the weather remains open, there will still be many crops sown in the remainder of this season. For such crops the value of " Ceresan " WB is especially great."

Biological Methods for the Evaluation of Rodenticides.

By E. W. Bentley, B.Sc., Ph.D., Technical Bulletin No. 8, *Published by Her Majesty's Stationery Office.*

This is a useful and informative publication upon the problems arising in the evaluation of rodenticides to quote, " One purpose of this bulletin is to discuss the characteristics required of the main types of rodenticides and to describe some of the methods that have been evolved for their investigation."

A classification of present day rodenticides is given and of these acute poisons, chronic poisons and poison dusts are discussed in some detail. The bulletin also discusses various laboratory methods used for determining the toxicity and palatability and their value in relation to actual use.

Difficulties, such as the estimation of the population before and after the experiment, which may arise in field trials are mentioned, as is the problem of correlating the results of laboratory and field tests with the results to be expected in actual use.

The Programme to Eradicate the Imported Fire Ant. July 1958.

By Dr. John L. George in a report to "The Conservation Foundation" and " The New York Zoological Society." Published by The Conservation Foundation.

Dr. George gives an account of the problems arising from the importation of the fire ant into Alabama around 1918 and its subsequent spread over 27 million acres.

He deals with the fire ant's life history, ecology and economic effects for which reports on the latter appear to be very contradictory.

An account of the control programme and its effect upon the fire ant, crops, wildlife, domestic animals and man, is given but the whole crux of the report appears to be summarised in the sentence " But mass spraying has come upon us so quickly and promises so many real benefits, that it is easy to overlook that it is a radically new procedure and easy to pass over its true cost, its real problems and, even its dangers."

The report is concerned with the discussion of these problems and dangers using the problem of the fire ant as a specific example.

NEWS
& NEW PUBLICATIONS

Board Changes in the Geigy Group

After almost 50 years with Geigy, Mr. C. F. Gysin retired at the end of 1958 as Chairman of the Board of Geigy (Holdings) Ltd.,of Manchester, and in consequence a number of changes have taken place as from 1st January, 1959 in the Boards of the companies of the Geigy group in Britain.

Mr. E. G. Turner succeeds Mr. Gysin as Chairman of Geigy (Holdings) Ltd., with Mr. H. L. Addleshaw continuing as Deputy Chairman. Mr. H. Clayton succeeds Mr. Turner as Chairman of The Geigy Company Ltd., with Mr. H. Jones as Deputy Chairman. Mr. H. Jones and Mr. G. A. Campbell become Joint Managing Directors. Mr. H. L. Addleshaw succeeds Mr. Gysin as Chairman of Ashburton Chemical Works Ltd., of Trafford Park, Manchester, with Dr. F. Buchmeier as Managing Director. On the Board of James Anderson & Co. (Colours) Ltd., of Paisley, Mr. A. H. Whitaker succeeds Mr. Gysin as Chairman and Mr. A. A. R. Osbourne and Dr. D. M. Stead become Joint Managing Directors.

Mr. F. Rath, Publicity Manager of The Geigy Company Ltd., of Manchester, has returned to Switzerland to take up an appointment with the Publicity Department of the parent company, J. R. Geigy S.A. of Basle.

Resignation

At its last meeting Council of The Fertiliser Society received with regret the resignation of Mr. A. I. Coleman from the office of Vice-President. Mr. Coleman has been ill and on his return to work after his convalescence finds it necessary, temporarily, to reduce his commitments.

At the same meeting Council elected Mr. J. Frisken, a member of Council, as Vice-President in succession to Mr. Coleman. Mr. Frisken's contributions to the discussions of the Society will be familiar to all members.

Mr. Anthony Keith Palmer, B.Sc., has joined Pest Technology, as from 5th January, as Technical Editor.

He is a graduate of Hull University, and in introducing him to our readers we are sure, when he meets members of the industry at various meetings, that a warm welcome will be accorded him.

I.C.I. Garden News: No. 1.

Published by Plant Protection Ltd., Yalding, Kent.

One important announcement in the first issue is that in the future the range of insecticides, fungicides and fertilisers made by Plant Protection Ltd., will be known as I.C.I. garden products. All advertising for the range will carry the I.C.I.'s well-known roundel prominently.

The idea, states " Garden News " is that: " I.C.I. is a better known brand name than 'P.P.' — in fact, one of the best-known brand names in the country."

It is felt that the change of brand name will give the company's advertising " much greater impact."

The publication, printed on card, opens out to give on the interior, Trade Price List for 1958/59 of I.C.I. Garden Products and Eureka Garden Products. There is a cord for hanging. Are we right in assuming this is " Terylene "?

Technical Information Sheets No.'s 5/4 and 5/7.

Published by Standardised Disinfectants Co. Ltd., 23 Sloane Street, London, S.W.1.

The first—Leaflet 5/4—is a new leaflet referring to Brunobait for destruction of snails and slugs. These pests cause serious damage every year on farms, nurseries, allotments and in gardens. Particularly are they voracious feeders, doing damage to young seedlings.

Advisory leaflet 115 of the Ministry of Agriculture, Fisheries and Food, entitled " Slugs and Snails " describes those of agricultural importance.

Metaldehyde, as is known, is probably the most deadly chemical for destruction of slugs and snails and this acts best when formulated as a bait. Brunobait contains metaldehyde together with a strongly attractive bait and is prepared in the form of pellets for easy broadcasting or for spot application. An important feature is Brunobait's resistance to rain and watering.

Leaflet 5/7 refers to Brunozeb formulations of Zineb. This is a highly effective, reasonably priced fungicide which protects plants from a considerable number of diseases. Its toxicity to warm blooded animals is very low and it is a safe chemical to use.

Two Brunozeb formulations of zineb are currently available: Brunozeb dispersible powder (65 per cent. zineb) and Brunozeb Z5, a ready for use suspension in oil for ultra-low-volume application at rates of 1-2 gallons per acre.

Sports' Turf Bulletin No. 44. January -March, 1959.

Published by The Sports Turf Research Institute, St. Ives Research Station, Bingley, Yorks.

An all-too short article on the propagation of turf fungi and some interesting notes about the maintenance of German golf courses are included in this issue.

New premises of Chisholm Fox & Garner Limited.

New Premises at Lincoln for Chisholm, Fox and Garner Ltd.

In the October issue of "P.T." we carried a photograph showing work in progress on the new premises of Chisholm, Fox and Garner Ltd., along the Wragby Road, Lincoln.

Recently these new premises were opened—a modern office block and showrooms.

This marked the completion of a large-scale building programme begun in April 1957. These new premises, which include 20,000 sq. feet of warehouse and factory accommodation, provide the Company with a worthy headquarters in the important grain growing area of Lincolnshire.

The firm of Chisholm, Fox and Garner Ltd., has for many years played a prominent role in Lincolnshire's agriculture. Their service of lending out sacks on hire to farmers and corn merchants, for the storage and transportation of grain, has fulfilled an essential function, and has been constantly expanding. In addition to the Wragby Road premises, they own several warehouses and have over fifty Depots covering Lincolnshire.

The story of the start and the growth of Chisholm, Fox and Garner Ltd., is a fascinating one. A hundred and fifty years ago, when farmers ground their own corn, sacks were little used. It was then that a far-sighted woman called Elizabeth Fox realised that there was an opportunity for someone to supply sacks on a hire basis to farmers who took their own corn to the windmill to be ground. She formed the firm of E. Fox and Son—pioneers of the Sack Hire trade. From this small beginning grew the present huge sack concern of Chisholm, Fox and Garner Ltd., with its head office in Hull, and branch offices at Lincoln, Sawbridgeworth, Liverpool and Edinburgh. Amalgamated with the West of England Sack Contractors Ltd., they are part of the biggest Group of sack contractors in the United Kingdom.

Chisholm, Fox and Garner Ltd., have over the years developed an ancillary business by supplying their customers with sundry agricultural machinery and equipment, and also farm buildings of all types, including Dutch Barns, "Agregon" Pre-Cast Concrete Buildings, and Multi purpose Buildings, etc. Latterly, a Spray Division was inaugurated, and a full range of highest quality weedkillers, insecticides and fungicides, marketed under the name of "Juvare" Crop Sprays, is available. An aerial spraying service was successfully operated this year for the application of Colloidox Copper Fungicide using Tiger Moth machines with rotary atomisors.

In the new building the warehouse and factory sections are constructed of brickwork with steel framed roof structure, and the latter is especially interesting in that it has been designed to the new "plastic theory" which results in economies and superior maintenance properties. Modern design techniques have been employed to provide a high degree of fire resistance and thermal insulation. Another feature of special interest is the heating installation which is designed to provide small areas of working comfort within an otherwise unheated large space. This is a dual system comprising a new type of overhead radiant heating from an oil fired low pressure hot water system, and an electrically warmed floor.

The impressive office block possesses a reinforced concrete frame, part of which is pre-stressed; large sections were pre-cast to reduce construction time. The upper storey is clad with Canadian Red Cedar; the front entrance is accentuated by a specially sculptured fountain. The architects responsible were Warren-Neil and Partners, F./A.R.I.B.A., of Lincoln and London.

The Editor,
"Pest Technology."

29th December, 1958.

Dear Sirs,

We find the monthly issues of your Journal extremely interesting and helpful and trust you will continue to send us copies of the same interest.

Perhaps you could help us on two points.

1. Could you give us the name and address of suppliers in this country of monuron and simazin so that we can obtain further details, price etc.
2. In Dr. Woodford's address to the B.W.C. Conference, reported by you, he says:
   ". . . . seem to have little idea of the precise meaning of synergism." Page 68.

Can you elucidate simply?
With thanks.

Yours faithfully,
A. Longthrin,
Field Advisory Officer,
The Dorset Farmers Ltd.,
Unity Chambers, Dorchester.

(This has been done.— Editor, P.T.)

The ultra-low pressure spraying system developed by The Dorman Sprayer Co. Ltd., with the main object of eliminating wind-drift.

News of the Industry

At Nakuru, Kenya. Seen outside their headquarters are some of the principal officials of The Pyrethrum Board of Kenya on the occasion of the visit recently of Dr. T. F. West, D.Sc., Ph.D., F.R.I.C., European Operations Executive of the African Pyrethrum Technical Information Centre Ltd.

Left to right are: Mr. W. J. Lucking, Deputy Executive Officer, Dr. A. A. Goldberg, Director of Scientific Services, Mr. N. H. Hardy, O.B.E., Executive Officer, Dr. J. R. Furlong, Liaison Executive, APTIC., Dr. West and Mr. J. Huntley, Pyrethrum Extraction Plant Manager.

Dr. West has just returned from Kenya. Main purpose of this visit was to compare results of United Kingdom research into the use of Pyrethrum-based insecticides with those of the work of scientists at the laboratories at Nakuru of the Pyrethrum Board of Kenya, and to draw any possible conclusions about the wider use of the product of this important East African industry.

The Villiers Engineering Co. Ltd., of Wolverhampton, held an Exhibition in the Royal Horticultural Society's New Hall, London, S.W.1, on 7th January, to mark their Diamond Jubilee.

A souvenir brochure entitled, "Sixty Progressive Years" gives a fascinating and all-too-brief review of the growth of the Villiers Group of Companies in this period.

In the brochure was listed those manufacturers of products powered by Villiers Group Engines, and these include the following:

SPRAYING AND DUSTING EQUIPMENT

- E. Allman & Co. Ltd., Birdham Road, Chichester, Sussex.
- J. W. Chafer Ltd., Milethorn Lane, Doncaster.
- Cooper Pegler & Co. Ltd., Burgess Hill, Sussex.
- W. J. Craven & Co. Ltd., Port Street, Evesham, Worcs.
- Dorman Sprayer Ltd., Dittons Walk, Cambridge.
- Drake & Fletcher Ltd., Maidstone, Kent.
- Four Oaks Spraying Machine Co. Ltd., Four Oaks, Sutton Coldfield
- Lister-Todd Engineering Corporation Ltd., Dursley, Gloucestershire.
- Micron Sprayers Ltd., 54/56 Battersea High Street, London, S.W.11.

Those who purchase from these companies can rest assured that products are powered by precision-built engines with sixty years of British workmanship behind them.

The above illustration shows a new small Plot Sprayer which has been developed by E. Allman & Co. Ltd. of Birdham for Messrs. Unilever Ltd. This machine has been designed for use where small quantities of chemical are to be applied for experimental purposes.

It is a portable unit and can easily be carried and operated by one person. The whole machine is carried by the operator in a knapsack position, this leaves the operator with complete freedom of movement for spraying operations.

The pressure is obtained from a small compressed air cylinder which is conveniently situated in the frame for easy and rapid removal when empty. The price of the Unit complete is £59 10s. 0d.

Shepherd's Aerosols Limited, Manufacturers of the Aerovap Electric insecticide vaporiser are extending their Organisation to meet the demands for their units. Recently they moved into new and larger administrative offices at Shernfold Park, Frant, Tunbridge Wells. A new Factory is being built at High Brooms, Tunbridge Wells, for continued development of all the Companies activities. A Sales Office will continue in London at 1, Old Burlington Street, W.1. and the Northern Office remains at Asia House, 82, Princess Street, Manchester 1.

Research and Laboratories continue at Goring-on-Thames.

What's On . . . . When . . . . and Where

(*Hon. Secretaries are invited to send in details for inclusion in this column*).

Industrial Pest Control Association:
10th February.

" Some Experiences of Pest Control in the U.S.A. from a recent visit "—Mr. S. W. Hedgcock.

10th March.

" Progress in bird control measures "—lecturer to be decided.

Hotel Rembrandt, South Kensington, London, S.W.7 following Association luncheons.

The Fertiliser Society:
17th February.

"The Mechanism of Granule Formation" by Professor D. M. Newitt, D.Sc., F.R.S. 2-30 p.m. in the Lecture Hall of the Geological Society, Burlington House, Piccadilly, London, W.1.

17th March.

" Francis New Memorial Lecture " by H. U. Cunningham, M.C., C.B.E. 2-30 p.m. in the Lecture Hall of the Geological Society, Burlington House, Piccadilly, London, W.1.

Society of Chemical Industry:
16th February.
" The Role of Surface Active Substances in the Application of Pesticides." by Dr. G. S. Hartley (Joint Meeting of the Pesticides Group and Surface Activity Group). 14 Belgrave Square, London, S.W.1, at 5-30 p.m.

The Surface Activity and Pesticides Groups have decided to hold a Joint Dinner on Monday, 16th February, 1959, following the lecture by Dr. G. S. Hartley.

The Dinner will be held at the Windsor Castle Hotel, Victoria, London, S.W.1, and the time will be 7-15 p.m. for 7-45 p.m. Dress will be informal. Cost of tickets (exclusive of wines) will be 20/- single, 37/6 double (lady and gentleman). This will be the first occasion on which members of the newly formed Surface Activity Group and their friends will be able to meet socially and the President of the Society, Sir Robert Robinson and Lady Robinson hope to be present.

The Plastics Institute:
11th March.

" International Competition in the Chemical Industry," by S. P. Chambers, C.B., C.I.E. (Deputy Chairman, Imperial Chemical Industries Ltd.). The Plastics Institute, Tenth Annual Lecture. 6-30 p.m. at The Wellcome Foundation Building, Euston Road, London, N.W.1 (near Euston Square Station).

(Admittance by ticket only, obtainable from The Plastics Institute, 6, Mandeville Place, London, W.1.)

International Plastics Exhibition, Olympia, London.
17th-27th June.

Thirteen overseas' countries have indicated already their intention of taking part in the 1959 Exhibition.

The North Riding of Yorkshire Education Committee :
10th-12th April.

Week-end Course for Groundsmen. Wrea Head College, Scarborough.

Two lectures are to be given in the near future, and because of the interest which has been created we print below summaries of these.

The first on the 16th February is by Dr. G. S. Hartley, to the Pesticides and Surface Activity Groups of the Society of Chemical Industry on " The Role of Surface Active Substances in the Application of Pesticides."

Summary

These compounds are used in the formulation of pesticides for two main reasons. (1) To disperse solid particles or liquid droplets in water, and (2) to assist the spread on the surface sprayed, of the water which carries the pesticide. The dispersion and emulsion roles under (1) are common to many similar applications in industry, but under (2) we meet problems more peculiar to agriculture. Spreading may not always be desirable but is not easily avoided if good emulsifiers or dispersers are used. The possibility of active assistance in penetration of insect or plant cuticle is frequently sought, but not unambiguously attained. Modern industrial development has placed a wide range of surface active compounds at the disposal of the formulator. The main types will be reviewed and some unsolved problems will be discussed.

Then on the 12th March, the Deputy Chairman of Imperial Chemical Industries Ltd., (Mr. S. P. Chambers, C.B., C.I.E.) will give the Tenth Annual Lecture of the Plastics Institute.

Summary

The pattern of world trade in chemicals will be discussed and exports analysed, (a) according to the country of origin, with an indication of the proportion of total production exported, (b) the classes of chemicals exported, showing which appear to be growing in volume and which declining, giving the reasons as far as this is possible, (c) the markets to which the chemicals are exported, with an indication of the strength or weakness of these markets, and (d) the nature of the competition which British chemical exports are experiencing and are likely to experience from other countries, with special references to the competition from behind the Iron Curtain. The extent to which Iron Curtain competition can be expected regardless of costs, and the extent to which some of this competition may be based on genuinely low costs will be examined. The manner in which productive capacity in the chemical industries behind the Iron Curtain is being built up and the fundamental differences between the attitude in Russia and that in other countries to the problems of production and export in those countries will be discussed. The significance of these differences for different classes of chemicals, with particular reference to plastics, will be the subject of some broad conjectures. Some general conclusions will be drawn as to how this and other competition overseas might be met.

4th BRITISH WEED CONTROL CONFERENCE

(**Abstracts** *continued from January issue*)

" . . . . good reasons for employing herbicides of the contact type . . . . "

EXPERIMENTS WITH HERBICIDES ON BEDS OF NARCISSUS AND TULIP 1955-58.

By J. Wood and S. J. Howick,
Kirton Experimental Husbandry Farm

Introduction

In the last report on herbicide trials on bulb crops at Kirton[1] attention was drawn to the promising results obtained with CIPC as a pre-emergence herbicide. The urgent need for post-emergence herbicides was stressed. Peabody,[2] in America, reported favourably on CIPC for post-emergence use on daffodils in 1953, but a cautious approach seemed justified in this country. Injury to tulips and narcissus by monuron has occurred, and flower-bud injury by TCA in narcissus has emphasised the need for thorough trials to assess crop tolerance.

Little is known about cumulative effects of repeated herbicide applications on bulbs, or the limitations of CIPC.

Experimental

Only small field plots of 50 bulbs are used, but the previous history of the stocks is known. Though the stocks are grown as a crop in a farm crop rotation, where the appropriate dressings of dung and fertilisers are applied to other crops as required in good husbandry, the bulbs receive no fertilisers directly. After being graded to commercial standard, they are re-selected to obtain identical plot weights at planting. They are planted 5 bulbs per row 6″ apart in 10 rows 8″ apart, the position of each bulb being fixed by a marking frame as in the Dutch bed system.

An Oxford Precision Sprayer is used to apply the sprays. Use is also made of a light alloy skeleton box-frame which fits well over the plot. Polythene sheeting is fixed round the frame. The middle lateral alloy stays are fixed at required height, with a narrow ledge projecting internally, on which the spray boom rests. Easy movement is facilitated by runners fitted at each end of the boom. In operation the boom is pushed along at a predetermined speed, timed by a stopwatch.

The herbicides used are supplied by the ARC Unit of Experimental Agronomy, Oxford, with whom there is close collaboration in the selection of materials for trial.

Records taken include, weather conditions, visual assessment of weed populations and species present, herbicidal effects and crop tolerance, and crop yields at harvest. Dissection of dry bulbs, to observe effects of herbicides upon flower bud initiation and development has also become essential.

Observation

Though it was assumed that CIPC would be more difficult to use effectively as a post-emergence treatment, information on this point was meagre as far as bulb crops were concerned. It was found that applications of CIPC 4 lb./acre in April could cause irregularity of stem length in tulip, and scorching of leaves at soil level in narcissus. Simple tests with other potential post-emergence herbicides indicated that at a rate of $\frac{1}{2}$ lb./acre on tulip cultivar Wm. Pitt, both diuron and neburon caused injury, and control of weeds was poor. With fenuron and simazin there was no obvious injury, and the latter seemed very promising for further trial. Narcissus King Alfred showed tolerance to fenuron and simazin applied at 2 lb./acre.

Discussion

The aim of the experiments conducted was to discover if possible whether repeated application of herbicides could have an injurious effect upon narcissus and tulip crops. There would appear to be some evidence in support of this contention as judged by the delay in flowering where CIPC was used in two consecutive years, though the retardation was slight.

It was also intended to assess the value of CIPC as a post-emergence herbicide. Failure to control *Matricaria* was not anticipated, and this occurrence calls for great care in timing applications of this material, since at a rate higher than is generally used it was unsatisfactory. The question is thus raised regarding the best type of herbicide to use on narcissus and tulip at the pre-emergence stage of bulb growth. There would appear to be good reasons for employing herbicides of the contact type as residual pre-emergence sprays, to enable CIPC to be used in post-emergence applications.

Sodium arsenite followed by CIPC gave satisfactory results, but the year was favourable to sodium arsenite, which in 1955 was less effective. The requirements would appear to be for a pre-emergence herbicide not so readily affected by rainfall, and PCP has a good claim for consideration at a rate lower than used in the Kirton experiments.

If used as a pre-emergence treatment CIPC has limitations against which some safeguard would seem to be required to ensure control of those weeds on which it has only a limited effect.

In post-emergence use CIPC is likely to cause injury to the bulb crop when applied after March, and when weather conditions probably increase the susceptibility of the crop to injury. Only when the limitations of CIPC are more clearly defined will its practical value be established. Moreover, with herbicides capable of being translocated, the task of assessing crop tolerance is becoming increasingly difficult. Experiments conducted at Kirton E.H.F. Lincs. and Rosewarne E.H.S. Cornwall have not always given identical results in the assessment of crop tolerance, though the difference has been one of degree, apparently due to climatic conditions.

Herbicides which promise to be of use for post-emergence application on bulb crops are a welcome addition to the means of achieving satisfactory control but there is need for more extensive trials, and thorough screening of the materials available.

REFERENCES

[1] Wood, J. and Howick, S. J. *Proc. 3rd Brit. Weed Control Conf.*, 1956, 697.

[2] Peabody, D. V. *Proc.* 1953 *Bulb Growers Short Course, Northwest Bulb Growers' Association, Washington, U.S.A.*, 39.

" . . . . less danger of spray damage to the crop."

USE OF DINITRO-COMPOUNDS FOR PRE-EMERGENCE WEED CONTROL IN PEAS.

By O. G. Goodman,
Johnstown Castle Agricultural College Wexford.

Introduction

Chemical weed control in peas has been given much attention in recent years, and the greatest proportion of the work has been with dinitro compounds applied in the post-emergence period. While excellent progress has been made, the influence of weather conditions around the time of spraying has led to variable results and consequent conservatism amongst some growers in the use of this method of weed control in their crop.

The work reported here resulted from a series of experiments on the control of weeds in peas which commenced in 1953 with the general aim of finding which of the materials being recommended for weed control had most promise.

Relatively few references had been noted in the literature to the use of the dinitro-compounds for pre-emergence weed control in peas. Leefe[1] did report satisfactory results with 4-8 lbs. of the amine salt of dinoseb applied prior to emergence. Hemphill *et al.* [2]recommend 6-8 lb. per acre of the ammonium salt for application at least two days before emergence of the crop.

Preliminary field trials in the present work showed that rates of dinoseb of the order of those used by Leefe and Hemphill *et al.* gave promise of good weed control without damage to the crop when applied prior to emergence, and that DNC was also effective when used in a similar manner. Further trials were therefore continued as reported below.

Experimental

The experiments in all cases were of randomised block design with five fold replication. Plot size was 0.0014 acres. All sprays were applied at 100 gallons per acre, full precautions being taken to ensure even distribution of the spray, and a suitable movable guard was used to prevent drift. Weed counts were made within three weeks of application by the random quadrat method and a plant was considered to be alive as long as green tissue was noticeable. Notes were taken on the condition of the crop where it was checked by treatment and yields of peas were recorded. Onward was the variety used throughout. The ammonium salt of dinoseb and the activated sodium salt of DNC were the formulations used.

Discussion

The results of the above experiments are in agreement with those of Leefe[1] and indicate that approximately 4 lb. per acre of the ammonium salt of dinoseb will give good control of broad-leaved weeds, and some control of *Poa annua* when applied prior to emergence. It would appear that successful results may be obtained by applications made any time from the sowing of peas to approximately three days before emergence. This latitude with regard to the time for effective application is important especially for pre-emergence treatment, and could perhaps result in sowing and weed control being done in one operation. The peas were not damaged by these pre-emergence applications, and yield was much better than where 2 lb. per acre was applied after emergence, when the plants were 2.5 inches high.

Where TCA is to be incorporated with dinoseb for the control of grass it would appear necessary to spray soon after sowing the crop to avoid damage. While there was evidence of some damage to the crop in the early stages of development by such an application of 10 lb. of TCA in conjunction with 4 lb. of dinoseb, final yield was satisfactory as a result of better weed control. Applications of approximately 2 lb. per acre of CIPC in conjunction with 4 lb. of dinoseb after sowing have also given encouraging results.

It is noteworthy that successful control of broad-leaved weeds was obtained in the above instances when the maximum temperature was as low as 50°F at the time of application, which took place before the emergence of the weeds. It also indicates the value of dinoseb as a soil sterilant herbicide.

The results of the present experimental work also show that DNC is satisfactory for the control of dicotyledonous weeds in peas when applied before emergence as the activated sodium salt at 6—8 lb. per acre. Though the higher rate may cause a slight check, the plants normally regain their vigour. The results appear to indicate that this herbicide may be applied any time from sowing to within three days of emergence, as found in the case of dinoseb. Reasonably good control of *Poa annua* may be expected at rates in the region of 9 lb. per acre. There is, of course, the possibility of incorporating a grass killer at lower rates of application. Further investigation would need to be done on these, and other points, under varying soil and weather conditions before a final decision could be reached.

Conclusion

It would appear that Dinoseb and DNC hold promise as post-sowing herbicides for weed control in peas, especially the former. Where grasses are a problem there is an indication that a suitable grass herbicide such as TCA or CIPC may be added with advantage. To offset the extra cost of using a higher rate per acre, in the case of dinoseb, than that normally used in post-emergence spraying is the fact that (a) there is less danger of spray damage to the crop; (b) there need be no weed check to the crop which may occur in weedy field where one has to wait to the four leaf stage before spraying as commonly happens with post-emergence spraying; (c) one is less dependent on weather conditions and (d) there is the possibility of doing sowing and weed control in one operation.

REFERENCES

[1] Leefe, J. S. (1953) *Proc. 7th Sec. Nat. Weed Comm. Canada.*

[2] Hemphill, D. D., Murneek, A. E. and Smith, J. E. (1951) *Bull. Mo. agric. exp. Sta.*